

Review of Growth and Structural Characterization of Nonlinear Optical Single Crystals

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Abstract

Nonlinear optical (NLO) single crystals have attracted considerable attention because of their important applications in laser technology, optical communication, frequency conversion, photonic devices, and advanced optoelectronic systems. This review examines the methods used for the growth and structural characterization of nonlinear optical single crystals, with emphasis on the relationship between crystal structure, growth conditions, and optical performance. Various crystal-growth techniques, including slow evaporation, slow cooling, temperature-gradient methods, flux growth, and the Czochralski technique, are discussed in relation to their suitability for producing high-quality single crystals. The study reviews the importance of controlling parameters such as temperature, solvent composition, pH, supersaturation, cooling rate, and growth environment to obtain crystals with desirable size, morphology, purity, and optical quality. Structural characterization techniques such as single-crystal and powder X-ray diffraction are considered essential for determining crystal structure, lattice parameters, crystallinity, and phase purity. Complementary techniques, including Fourier-transform infrared spectroscopy, Raman spectroscopy, UV–Visible spectroscopy, thermal analysis, and electron microscopy, provide additional information about molecular bonding, optical transparency, thermal stability, and surface morphology. The review further highlights the significance of structural defects and impurities in determining the nonlinear optical response of crystals. Understanding the relationship between growth conditions, structural properties, and NLO behaviour is essential for developing crystals suitable for technological applications. The study concludes that systematic optimization of crystal-growth processes and comprehensive characterization can improve the quality and functional performance of nonlinear optical single crystals.

Keywords: Nonlinear Optical Crystals, Single Crystal Growth, Structural Characterization, X-Ray Diffraction, Crystal Structure, Optical Properties, Crystal Growth Techniques, Spectroscopy, NLO Materials, Photonics, Frequency Conversion, Optoelectronics.

